

This is a Continuation-In-Part of Application No. USSN10/129,437 filed on May 6, 2002

Title

Thermal Expansion Compensation for Printhead Assembly

Field of the Invention

5 The present invention relates to printers, and in particular to digital inkjet printers.

Co-Pending Applications.

Various methods, systems and apparatus relating to the present invention are disclosed in the following co-pending applications filed by the applicant or assignee of the present invention on 24 May 2000:

10	PCT/AU00/00578	PCT/AU00/00579	PCT/AU00/00581	PCT/AU00/00580
	PCT/AU00/00582	PCT/AU00/00587	PCT/AU00/00588	PCT/AU00/00589
	PCT/AU00/00583	PCT/AU00/00593	PCT/AU00/00590	PCT/AU00/00591
	PCT/AU00/00592	PCT/AU00/00584	PCT/AU00/00585	PCT/AU00/00586
	PCT/AU00/00594	PCT/AU00/00595	PCT/AU00/00596	PCT/AU00/00597
15	PCT/AU00/00598	PCT/AU00/00516	PCT/AU00/00517	PCT/AU00/00511

Various methods, systems and apparatus relating to the present invention are disclosed in the following co-pending application, PCT/AU00/01445, filed by the applicant or assignee of the present invention on 27 November 2000. The disclosures of these co-pending applications are incorporated herein by cross-reference. Also incorporated by
20 cross-reference are the disclosures of two co-filed PCT applications, PCT/AU01/00261 and PCT/AU01/00259 (deriving priority from Australian Provisional Patent Application No. PQ6110 and PQ6158). Further incorporated are the disclosures of two co-pending PCT applications filed 6 March 2001, application numbers PCT/AU01/00238 and

PCT/AU01/00239, which derive their priority from Australian Provisional Patent Application nos. PQ6059 and PQ6058.

Background of the Invention

Recently, inkjet printers have been developed which use printheads manufactured by
5 micro-electro mechanical systems (MEMS) techniques. Such printheads have arrays of
microscopic ink ejector nozzles formed in a silicon chip using MEMS manufacturing
techniques. The invention will be described with particular reference to silicon printhead
chips for digital inkjet printers wherein the nozzles, chambers and actuators of the chip are
formed using MEMS techniques. However, it will be appreciated that this is in no way
10 restrictive and the invention may also be used in many other applications.

Silicon printhead chips are well suited for use in pagewidth printers having stationary
printheads. These printhead chips extend the width of a page instead of traversing back and
forth across the page, thereby increasing printing speeds. The probability of a production
defect in an eight inch long chip is much higher than a one inch chip. The high defect rate
15 translates into relatively high production and operating costs.

To reduce the production and operating costs of pagewidth printers, the printhead
may be made up of a series of separate printhead modules mounted adjacent one another,
each module having its own printhead chip. To ensure that there are no gaps or overlaps in
the printing produced by adjacent printhead modules it is necessary to accurately align the
20 modules after they have been mounted to a support beam. Once aligned, the printing from
each module precisely abuts the printing from adjacent modules.

Unfortunately, the alignment of the printhead modules at ambient temperature will change when the support beam expands as it heats up to the temperature it maintains during operation.

Summary of the Invention

5 Accordingly, the present invention provides a printhead assembly for an inkjet printer, the printhead assembly comprising:

 a support member for mounting the printhead assembly within an inkjet printer, and, a plurality of printhead modules mounted to the support member;

 the support member has an overall coefficient of thermal expansion such that it
10 changes its dimensions between its production temperature, when the printhead is assembled, and an operation temperature reached during normal operation of the printer; wherein,

 the printhead modules are mounted to the support member at the production temperature such that they align when the printhead assembly is at the operating
15 temperature.

 Printhead assemblies according to the present invention use a composite support member so that one component can be a high strength low cost material such as steel, and another component can be selected so that the overall coefficient of thermal expansion of the support member matches, or is at least closer to, that of the printhead modules. Using
20 the known properties of the printhead module material and the support beam materials, the modules can be mounted with a degree of misalignment that will ensure that they align when the operating temperature of the printer is reached. By reducing the difference between the thermal expansion of the printhead modules and the support member, the printing alignment of individual modules with their adjacent modules is easier.

Preferably, the support member is a beam and the printhead modules include MEMS manufactured chips having at least one fiducial on each;

wherein,

the fiducials are used to misalign the printhead modules by a distance calculated

5 from:

i) the difference between the coefficient of thermal expansion of the beam and the printhead chips;

ii) the spacing of the printhead chips along the beam; and,

iii) the difference between the production temperature and the operating

10 temperature.

Conveniently, the first component of the beam is an outer metal shell, and the second component of the beam is a core of silicon with the outer metal shell. In a further preferred embodiment, the beam is adapted to allow limited relative movement between the silicon core and the metal shell. To achieve this, the beam may include an elastomeric layer
15 interposed between the silicon core and metal shell. In other forms, the outer shell may be formed from laminated layers of at least two different metals.

Brief Description of the Drawing

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawing in which:

20 Figure 1 shows a schematic cross section of a printhead assembly according to the present invention.

Detailed Description of Preferred Embodiments

Referring to the figure the printhead assembly 1 has a plurality of printhead modules 2 mounted to a support member 3 in a printer (not shown). The printhead module includes

a silicon printhead chip 4 in which the nozzles, chambers, and actuators are manufactured using MEMS techniques. Each printhead chip 4 has at least 1 fiducial (not shown) for aligning the printheads. Fiducials are reference markings placed on silicon chips and the like so that they may be accurately positioned using a microscope.

5 According to one embodiment of the invention, the printheads are aligned while the printer is operational and the assembly is at the printing temperature. If it is not possible to view the fiducial marks while the printer is operating, an alternative system of alignment is to misalign the printhead modules on the support beam 3 such that when the printhead assembly heats up to the operating temperature, the printheads move into alignment. This
10 is easily achieved by adjusting the microscope by the set amount of misalignment required or simply misaligning the printhead modules by the required amount.

The required amount is calculated using the difference between the coefficients of thermal expansion of the printhead modules and the support beam, the length of each individual printhead module and the difference between ambient temperature and the
15 operating temperature. The printer is designed to operate with acceptable module alignment within a temperature range that will encompass the vast majority of environments in which it expected to work. A typical temperature range may be 0⁰C to 40⁰C. During operation, the operating temperature of the printhead rise a fixed amount above the ambient temperature in which the printer is operating at the time. Say this
20 increase is 50⁰C, the temperature range in which the alignment of the modules must be within the acceptable limits is 50⁰C to 90⁰C. Therefore, when misaligning the modules during production of the printhead, the production temperature should be carefully maintained at 20⁰C to ensure that the alignment is within acceptable limits for the entire range of predetermined ambient temperatures (i.e. 0⁰C to 40⁰C).

To minimize the difference in coefficient of thermal expansion between the printhead modules and the support beam 3, the support beam has a silicon core 5 mounted within a metal channel 6. The metal channel 6 provides a strong cost effective structure for mounting within a printer while the silicon core provides the mounting points for the
5 printhead modules and also helps to reduce the coefficient of thermal expansion of the support beam 3 as a whole. To further isolate the silicon core from the high coefficient of thermal expansion in the metal channel 6 an elastomeric layer 7 is positioned between the core 5 and the channel 6. The elastomeric layer 7 allows limited movement between the metal channel 6 and the silicon core 5. It will be appreciated that the maximum relative
10 movement between the channel and the core will be known from the known properties of the materials used, and the known difference between the production temperature and the known operating temperature. From this, it is a simple matter to select a suitable elastomeric material and a suitable thickness of the elastomeric layer. In this way the thermal expansion of the metal channel or the core (or indeed the support beam as a whole)
15 is not constrained but the normally high degree of thermal of the channel is significantly reduced.

The invention has been described with reference to specific embodiments. The ordinary worker in this field will readily recognise that the invention may be embodied in many other forms.